Claims

1. An integrated mass spectrometer device formed from two multilayer wafers, each wafer having an inner layer, an outer layer and having an insulating layer provided therebetween, the device having a plurality of electrode rods and a plurality of electrodes, the electrodes and electrode rods being formed on distinct layers of the wafers.

2. The device as claimed in claim 1 wherein each of the multilayer wafers has at least three layers which are combined to form a five layer structure.

3. The device as claimed in claim 1 or 2 wherein the electrode rods are mountable in the outer layers of each wafer.

4. The device as claimed in claim 3 wherein the outer layers of each wafer are dimensioned to receive the electrode rods therein, the electrode rods being retained in contact with the outer layer by the provision of at least one resilient member formed in the outer layer.

5. The device as claimed in claim 4 wherein the at least one resilient member is provided by a spring formed in the wafer.

6. The device as claimed in claim 4 wherein the electrode rods are located by etched features in the outer layer of the wafer, the features being dimensioned so as to suitably receive a rod, and wherein the resilient members is formed by also etching the outer layer.

7. The device as claimed in any preceding claim wherein each

of the first and second wafers are patterned with an outer pattern on a first side, and an inner pattern on a second side.

8. The device as claimed in claim 7 wherein the patterns provided on the second side provides for ion source and ion collection components of the spectrometer.

9. The device as claimed in claim 7 or 8 wherein the insulating layer is provided in regions where the patterns overlap.

10. The device as claimed in any preceding claim wherein the first and second wafers or individual dies therefrom are bonded to form a monolithic block.

11. The device as claimed in claim 10 wherein the bonding of the first and second wafers is effected such that the electrode rods are located on an outer portion of the block and the electrodes in an inner portion of the block.

12. The device as claimed in any preceding claim wherein the electrode rods form a mass filter component of the mass spectrometer.

13. The device as claimed in claim 12 including four cylindrical electrode rods, each rod having its diameter and centre-to-centre separation correctly chosen for quadrupole operation.

14. The device as claimed in claim 12 or 13 wherein the horizontal separation of the cylindrical electrodes within each wafer is defined by lithography and deep reactive ion etching.

15. The device as claimed in any one of claims 12 to 15 wherein the vertical separation of the cylindrical electrodes is defined by the combined thickness of the two inner layers, which are bonded together during assembly.

16. The device as claimed in any preceding claim wherein at least some of the plurality of electrodes are adapted to form ion entrance optics.

17. The device as claimed in claim 16 wherein the ion entrance optics are formed by an einzel lens.

18. The device as claimed in claim 16 further including a cold cathode field emission electron source provided in front of the ion entrance optics.

19. The device as claimed in claim 16 further including an electron source selected from one of:

a) a hot-cathode source,
b) a DC discharge source
c) an AC discharge source,
d) an electrospray source.

20. The device as claimed in claim 16 wherein a pair of RF electrodes are placed in front of the ion entrance optics in order to create a plasma.

21. The device as claimed in claim 16 wherein the ion entrance optics are formed from an etched fluid channel combined with a set of electrodes that together define an electrospray source.

22. The device as claimed in any preceding claim wherein

each of the wafers are bonded silicon on insulator wafers.

23. The device as claimed in any preceding claim further including two or more distinct chambers, the provision of distinct chambers enabling the use of the device within a differentially pumped system.

24. The device as claimed in any preceding claim further including an ion source provided in a mesh configuration.

25. The device as claimed in any preceding claim wherein at least some of the plurality of electrodes are arranged in a mesh configuration.

26. The device as claimed in any one of claims 1 to 23 wherein at least some of the plurality of electrodes are configured in a tube arrangement.

27. The device as claimed in claim 26 wherein the tube arrangement provides a lens located at at least one of the entrance or exit to the electrode rods.

28. The device as claimed in any preceding claim wherein at least some of the plurality of electrodes are configured as ion reflectors.

29. The device as claimed in claim 28 wherein the ion reflectors are configured to provide a linear ion trap.

30. The device as claimed in any preceding claim further including a filament element adapted to provide a source of electrons, the filament element being configured as one of the following types:

a) an externally provided filament,

b) an integrally formed filament, or

c) a removable filament.

31. A mass spectrometer system including a device as claimed in claim 1 in combination with an ion source and/or an ion detector, at least one of the ion source and/or ion detector being provided externally to the device.

32. A mass spectrometer array comprising a plurality of devices as claimed in any preceding claim.

33. A mass spectrometer system comprising two or more devices as claimed in any one of claims 1 to 30, the two or more devices being provided in series so as to form a tandem mass spectrometer.

34. A mass spectrometer system as claimed in claim 33, wherein each of the devices forming the series of devices is a quadropole device and wherein a pair of RF electrodes are placed between the cascaded quadrupole devices in order to create a plasma.

35. A method of forming a mass spectrometer comprising the steps of:

a) etching an inner and outer pattern on a wafer, the inner and outer patterns defining components for the spectrometer,

b) bonding the wafer to a second wafer so as to form a multilayer stack device,

c) inserting at least one electrode rod into the device,

d) providing at least one electrode in the device and,

wherein the at least one electrode and at least one electrode rod are provided on distinct layers of the

wafers.

36. A method as claimed in claim 35 wherein at least one of the distinct layers is provided by an etching step including at least two masks.

37. A method as claimed in claim 31 or 32 wherein the step of providing the at least one electrode includes the provision of the at least one electrode in at least one of the following configurations:

a) a tube arrangement,

b) a mesh arrangement, and/or

c) a diaphragm electrode arrangement.

38. A method as claimed in claim 37 wherein a mesh arrangement is provided so as to define at least a portion of a perimeter of a source cage into which electrons may be injected from an external filament.

39. A method as claimed in claim 37 wherein the diaphragm electrode arrangement is provided in the form of a three-electrode configuration, inner and outer electrodes of the three electrode configuration being configured to operate at the same potential.